National Council for Osteopathic Research

Chair design, sitting, and health – a summary table of evidence

(Dec 2016)

Sitting and risks to health

The risks of extended sitting to health are not new. A six-fold increase in deaths from pulmonary embolism was reported during the World War 2 due to extended periods sitting in deckchairs in air raid shelters (Simpson, 1940). Morris et al also identified the hazards of high levels of sitting in their study of London bus drivers in the 1950s (Morris et al, 1953). More recent work has articulated a new condition: the e-thrombosis (Beasley et al, 2003). Although advice is now tailored to reduce the amount of time we spend sitting, there are also a considerable number of seats available which are intended to improve our posture and increase activity through the body while sitting.

Recent media reports have identified a number of different conditions which have associated sitting with different states of health. Healey et al. estimated that the average adults can spend between 50-60% of their day in sedentary activity (Healey et al, 2011). Work undertaken by Wilmot et al, 2012 identified that excessive sitting was associated with an increased risk of 112% for diabetes (Relative Risk: 2.12; 95% Credible Interval 1.61-2.78), 147% increase (Relative Risk: 2.47) for cardiovascular events (95% Confidence Interval 1.44 to 4.24), 90% increase in risk of cardiovascular

mortality (Hazard ratio: 1.90; Credible Interval 1.36 to 2.66), and 49% increased risk of all-cause mortality (Hazard Ratio: 1.49; Credible Interval 1.14 to 2.03). However, in 2015 a study was published by Pulsford et al. who reported their review of 5132 participants in a cohort study. They concluded that the risks were less dramatic as in previous research but the participants in this study reported higher than average levels of daily activity so the findings should be treated with some caution (Pulsford et al, 2015).

Although the number of designs for different types of chairs is increasing, evidence to support their benefits is still growing and is largely based on small pilot studies. A summary of some of the studies relating to different chair designs is shown in Table 1.

Table 1. Evidence table for studies examining different chair designs

Citation	Intervention	Research design	Number of participants	Measurements	Overall findings
Vaucher M, Isner-Horobeti ME, Dematteï C,et al. Effect of a kneeling chair on lumbar curvature in patients with low back pain and healthy controls: a pilot study. Ann Phys Rehab Med 2015;58(3):151-6.	Kneeling chairs	Cross-sectional matched study	10 patients with chronic low back pain (CLBP); 10 healthy patients.	Pelvic incidence, sacral slope, and lumbar curvature were measured for subjects in upright and slumped postures on a standard flat and kneeling chair.	Sacral slope and lumbar lordosis reduced in all participants between standing and sitting. There was less reduction in lumbar lordosis when sitting on a kneeling chair compared with a standard flat chair. This effect was present in CLBP patients and healthy subjects.
Lander C, Korbon GA, DeGood De, et al. The Balans chair and its semi-kneeling position: an ergonomic comparison with the conventional sitting	Balans chair	Comparator study involving two groups	Two groups of healthy subjects who spent 30 minutes in a Balans chair, and in a standard	EMG readings for cervical and paraspinal muscles were taken. Pedal cutaneous blood flow was measured with laser Doppler flowmetry. A	The standard office chair was rated as more comfortable than the Balans chair. Increased EMG readings were noted in

position.			office chair for 30 minutes. Sitting was in reverse order for each group.	questionnaire concerning the comfort of the two chairs was completed also.	the cervical and paraspinal muscles for the Balans chair. Pedal blood flow was increased by 15% in the Balans chair.
Bettany-Saltikov J, Warren J, Jobson M. Ergonomically designed kneeling chairs are they worth it?: comparison of sagittal lumbar curves in two different seating postures. Stud Health Technol Inform 2008;140:103-106	Kneeling chair.	Repeated measures within subject design.	Twenty healthy participants (9 male; 11 female) aged 18-35.	Lumbar curvature was measured using the Middlesbrough Integrated Assessment System (MIDAS) tool for sitting on a standard computer chair (SCC), sitting on an ergonomic kneeling chair (EKC) set at a 20° inclination, and standing.	The study suggested that EKC set at a 20° inclination maintained standing lumbar posture to a greater extent than when sitting on a SCC.
Gadge K, Innes E. An investigation into the immediate effects on comfort, productivity and posture of the Bambach saddle seat and a standard	Bambach saddle seat	A single system multiple baseline research design.	Four subjects were used and used both the Bambach saddle seat and a standard office	Thigh to trunk ankle was estimated for all subjects as a measure of optimum seating posture. Low back discomfort was evaluated, and	Low back discomfort ratings tended to increase over time irrespective of the chair being used. There were no differences in levels

office chair. Work. 2007;29(3):189-203.			chair for a designated period.	productivity was measured also.	of productivity between the two chairs, but the saddle seat promoted a greater trunk to thigh angle for all subjects.
Tobin R, Leavy J, Jancey J. Uprising: an examination of sit-stand workstations, mental health and work ability in sedentary office workers in Western Australia. Work. 2016;1-13.	Sit-stand workstations	A two-group pre-post study design.	A total of 18 subjects in the intervention group, and 19 in the control group.	A range of measures were taken including time spent sitting, standing and stepping, sit-stand transitions, and the number of steps taken. Work ability and physical and mental health were measured also using an online questionnaire.	The intervention group using the sit-stand desk recorded significantly decreased time in sitting (100minutes), and increased standing time by 99 minutes. There was a decrease in self-reported current work ability compared to a lifetime best. There was no significant difference in any other variables of interest.
Van Niekirk S-M, Louw QA, Grimmer K. Does a prototype "experimental"	"Experimental" chair designed to aid a user in	Development and validation study.	Twelve high school students spent fifteen	Fifteen minutes of 3-D posture measurements were taken in both types	The experimental chair provided more postural movements compared

chair facilitate more postural changes in computing adolescents compared to normal school chair? Work. 2016;55(1):63-75	changing posture.		minutes in the prototype chair and a school computer chair.	of chair. The frequency of postural movements was analysed by evaluating the number of flexion and pelvic rotation movements.	to the school computer chair.
Sohit K, Robertson MM. Implications of sit-stand and active workstations to counteract the adverse effects of sedentary work: A comprehensive review. Work. 2015;52(2):255-267.	Sit-stand workstations, treadmill workstations, and bicycle workstations.	Comprehensive literature review.	A total of 26 studies met the study inclusion criteria.	A range of variables were included in the review including the effectiveness of sit-stand workstations in the office or in a laboratory setting, comfort, performance, user satisfaction, sit-stand behaviours, kinematic and physiological measures.	The data suggest that some amount of standing during an 8-hour working day could be beneficial without having a detrimental effect on either comfort or productivity.
Gregory DE, Dunk NM, Callaghan JP. Stability ball vs. office chair: comparison of muscle activation and lumbar spine posture during prolonged sitting. Human	Stability balls.	Repeated measures within subject design.	A total of seven men and seven women who had been free of low back pain (LBP) for the past 12	EMG readings were taken for the thoracic and lumbar erector spinae muscles. Lumbar spine posture was measured using 3-D motion	Small changes in biological responses were reported for use between the two seating types. Increased discomfort

Factors. 2006;48(1):142-153.			months. Participants spent one hour each on the stability ball and on the standard office chair.	analysis. Participants were required also to record their discomfort on a 100mm visual analogue scale at the start of each sitting trial and at 15 minutes intervals.	was reported using the stability ball compared to the office chair.
Annetts S, Coales P, Colville R. A pilot investigation into the effects of different office chairs on spinal angles. Eur Spine J. 2012;21(Suppl2):S165-S170.	The dynamic Vari-kneeler, the dynamic Swopper, the Saddle chair, and a standard office chair with the back removed.	Repeated measures within subject design.	A total of 14 health subjects were included in the study and used all four chairs while conducting a typing task.	Pelvic and lumbar angles, neck angle and head tilt were measured using digital; photogrammetry.	The researchers concluded that the Saddle chair produced the most appropriate posture in the lumbopelvic region, and the Saddle and Swopper for the cervical region. No chair consistently produced an ideal posture across all body regions but the Saddle chair created the best posture among the four chairs investigated.

Car seats

Car seat design has been a specialist area of innovation and testing over many decades. A review of all of the studies in this area is beyond the scope of this article but one site which will be of interest to osteopaths is that produced by Scottish osteopath Bryan McIlwraith. Brian has published in this area (McIlwraith, 1996), and his car seat data site is a useful resource: http://www.car-seat-data.co.uk/

Research into different forms of ergonomic seating and the effects of sitting on our general health is a growing area of research as we sit for longer, and increased numbers of ergonomic products enter the market. The research contains many small pilot studies which can indicate promising effects but larger scale trials are needed to provide greater confidence in their conclusions. The important factor of individual patient preference is also a vital part of these studies but is currently less well explored.

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